CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

FORAMINIFERAL RESEARCH

VOLUME 11, PART 3

SEPTEMBER, 1935

CONTENTS

SHARON, MASSACHUSETTS, U. S. A.
1935

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

158. A FORAMINIFERAL FAUNULE FROM THE TYPE SAN LORENZO FORMATION, SANTA CRUZ COUNTY, CALIFORNIA

By J. A. CUSHMAN and H. D. HOBSON

The foraminifera described in this paper are from three localities within the upper one-third of the type San Lorenzo formation as defined in 1906 by Ralph Arnold, and as mapped in the Santa Cruz quadrangle, California, by J. C. Branner and associates for the United States Geological Survey. Some of the material here reported upon[1] was collected by Hubert G. Schenck in connection with his investigation of the Oligocene problem; credit is also due Phillip W. Reinhart and Robert M. Kleinpell for aiding the junior author in collecting samples. Types are deposited in the Cushman collection, paratypes in the collection of Stanford University, California.

Arnold designated the type San Lorenzo as that section of strata lying along the bed of the San Lorenzo River about two and one-half miles above the town of Boulder Creek, Santa Cruz Co., California. At this locality, the San Lorenzo formation consists essentially of about 2,500 feet of yellowish-buff shales, sandy shales and fine sandstones. The formation extends westwardly from the type locality into the vicinity of Big Basin where it rests conformably upon the coarse grained, yellow sandstones of the Butano formation of probable Eocene age. At the type locality and immediately adjoining areas, the San Lorenzo conformably underlies a second series of sandstones which the United States Geological Survey mapped as Vaqueros, commonly referred to the Lower Miocene. Since no diagnostic fossils were

[1] Hobson, Henry D. The Stratigraphic Significance of Foraminifera from the type San Lorenzo formation, California (Micropal. Bull., vol. 3, no. 2, March 1932, pp. 30-40; l. c., p. 114). Consult also Bull. Geol. Soc. Amer., vol. 44, pt. 1, Feb. 28, 1933, p. 217.

found in the strata referred to either the Butano or the Vaqueros at the type locality of the San Lorenzo, the exact ages of these formations are considered unsatisfactorily determined.

Two of the localities (1103 and 1102)[2] from which foraminifera were obtained, appear to represent approximately the same horizon. The third locality (987)[3] may represent a horizon some 500 feet stratigraphically lower than the other two localities. Localities 1103 and 1102 are from 290 to 350 feet stratigraphically below the San Lorenzo-Vaqueros contact as mapped by the United States Geological Survey. Locality 987 is 890 to 950 feet stratigraphically below beds containing abundant specimens of *Pecten sanctaecruzensis* Arnold.

The following are conclusions concerning the age relationships of the San Lorenzo foraminifera:

1. The San Lorenzo assemblage is not identical with any described faunule from the Pacific Coast of North America.

2. The San Lorenzo assemblage appears to be allied to that of certain strata on the Pacific Coast of North America, whose ages have been considered as younger than Tejon (Eocene), and older than Monterey (Miocene).

3. The San Lorenzo assemblage has affinities with faunules from: (1), near Mist, Columbia Co., Oregon, considered by Schenck to be Keasey, early Oligocene; and (2), from the Point Conception region, Santa Barbara Co., California, overlying or associated with the upper portion of the *Turritella variata* zone of Woodring.[4] This zone he considered to be late Eocene in age, but it is Oligocene (Lincoln) according to B. L. Clark.[5] The San Lorenzo assemblage also has affinities with faunules from (3) the lower member of the Rincon formation on Los Sauces Creek (Cushman and Laiming), and (4) the Vaqueros formation of the southern San Joaquin Valley (Barbat and von Estorff).

4. Kleinpell[6] believes the species from the upper 800 feet of the San Lorenzo to fall in his Zemorrian Stage.

The notes above are by the junior author.

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[2] L. S. J. U. Locality 1103 is on Kings Creek, near its confluence with the San Lorenzo River, Santa Cruz Co., California.
L. S. J. U. Locality 1102 is on Bear Creek, just north of the southernmost Vaqueros-San Lorenzo contact, Santa Cruz Co., California.

[3] L. S. J. U. Locality 987 is on Bear Creek, about 2,500 feet north of L. S. J. U. Locality 1102.

[4] Woodring, W. P. Age of the Orbitoid Bearing Limestones and *Turritella variata* Zone of the Western Santa Ynez Range, California (Trans. San Diego Soc. Nat. Hist., vol. 6, 1931, pp. 371-388).

[5] Clark, Bruce L. Questioned Boundaries for the Marine Oligocene of Western North America (Bull. Geol. Soc. Amer., vol. 43, no. 1, 1932, p. 289).

[6] Kleinpell, Robert M. Difficulty of Using Cartographic Terminology in Historical Geology (Bull. Amer. Assoc. Petr. Geol., vol. 18, no. 3, 1934, p. 377).

The main purpose of the present paper is to present notes and figures of the various species of foraminifera that they may be available to workers concerned with this problem, rather than to present arguments as to the probable age of the fauna itself. Nearly all the species are figured, but the specimens are not all as well preserved as might be wished, and identifications for this reason as well as from scarcity of available material must in a number of cases be left somewhat indefinite.

BATHYSIPHON sp(?) (Pl. 8, fig. 1)

Specimens of *Bathysiphon* have been recorded several times from the Tertiary of California, usually as fragmentary specimens only. Our figured specimen is probably nearest like *B. sanctaecrucis* Cushman and Kleinpell (Contr. Cushman Lab. Foram. Res., vol. 10, 1934, p. 1, pl. 1, figs. 1, 2). It is from Locality 987.

REOPHAX cf. PILULIFER H. B. Brady (Pl. 8, figs. 2 a, b)

There is only a single specimen of this species, partly crushed, and therefore does not warrant a final specific identification. The specimen which may be only a young stage has apparently three chambers, somewhat indistinctly separated, the wall made of rather coarse, flaky fragments, roughly cemented, the aperture with a definite, slightly projecting neck. Length 0.85 mm.; diameter 0.50 mm. The specimen is from Locality 987.

CYCLAMMINA cf. CLARKI G. D. Hanna (Pl. 8, figs. 3 a, b)

The figured specimen from Locality 987 is evidently somewhat distorted and crushed, but the resemblance to the specimen figured by Cushman and Schenck (Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 303, pl. 42, fig. 1) is rather striking.

CYCLAMMINA cf. INCISA Stache (Pl. 8, figs. 4 a, b)

The specimen here figured is from Locality 987, and seems to be in its original form and shape except for a possible slight compression. There are about ten chambers in the final coil, and the sutures are nearly radiate and but little depressed. In general characters it closely resembles the specimens previously referred to this species (Cushman and Laiming, Journ. Pal., vol. 5, 1931, p. 93, pl. 9, figs. 6 *a, b;* and Cushman and Barbat, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 32, pl. 5, figs. 2 *a, b*). Length 1.00 mm.; breadth 0.80 mm.; thickness 0.35 mm.

TEXTULARIA cf. GRAMEN d'Orbigny (Pl. 8, figs. 5 a, b)

There are a number of specimens of badly crushed Textularias in the collections from Localities 987 and 1102. These have been submitted to Dr. C. G. Lalicker, who has been working for the last three years on a monograph of Textulariidae, and he reports that they may be considered as falling within the limits of d'Orbigny's species.

VERNEUILINA sp(?) (Pl. 8, figs. 6 a, b)

There is a single specimen which is so badly crushed and distorted that evidently may be considered as belonging to this genus, but it seems inadvisable to use a specific name for it. It is from Locality 987. In some respects, particularly in the number and relative shape of the chambers, it resembles one of the figures of "*Verneuilina compressa* Andreae" from the Oligocene of Alsace (Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, pl. 8, fig. 3). Andreae's figured specimen was also evidently a crushed one.

ROBULUS sp(?) (Pl. 8, figs. 7 a, b)

The figured specimen is from Locality 1102. The species is rare in this material, but it may be of especial interest. In some respects, it resembles *Robulus clericii* (Fornasini), described from the Tertiary of Europe, and recorded from the Tertiary of Venezuela, Ecuador and Trinidad (See Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 84, pl. 12, figs. 16, 17). Howe and Wallace have also recorded it from the Eocene of Louisiana (Louisiana Geol. Bull. No. 2, 1932, p. 38, pl. 15, fig. 3). The sutures have a sigmoid curve, but there is not as great a tendency to expansion of the inner end in our figured specimen as in the typical form.

ROBULUS WARMANI Barbat and von Estorff (Pl. 8, figs. 8 a, b)

Robulus nikobarensis (SCHWAGER), var. *warmani* BARBAT and VON ESTORFF, Journ. Pal., vol. 7, 1933, p. 168, pl. 23, figs. 12 *a*, *b*.

The figured specimen is referred to the above species. The number of chambers is identical, although the umbilical region in our specimen is somewhat more umbonate. Similar specimens occur at Localities 1102 and 1103. From a study of this and other material, it would seem that this should be given specific rank, as it is not closely related to Schwager's species.

ROBULUS BARBATI Cushman and Hobson, n. sp. (Pl. 8, figs. 9 a, b)

Robulus politus BARBAT and VON ESTORFF (not SCHWAGER), Journ. Pal., vol. 7, 1933, p. 168, pl. 23, figs. 17 *a*, *b*.

Test bilaterally symmetrical, close coiled throughout, periphery distinctly keeled, very slightly if at all lobulate; chambers distinct, slightly if at all inflated, about 8 in the adult coil, of rather uniform shape, and increasing very gradually in size as added, the inner angle reaching only to the central umbo, leaving a large, clear area in the center; sutures distinct, limbate, not raised, slightly curved and generally tangential to the umbonal area; wall smooth, very finely perforate; aperture radiate, at the peripheral angle which is slightly extended, with the proximal slit enlarged. Diameter 0.65 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 22087) from San Lorenzo formation, Bear Creek, about 2,500 feet north of southernmost Vaqueros-San Lorenzo Contact, Santa Cruz Co., California. It also occurs at Locality 1103.

This is apparently identical with the species figured by Barbat and von Estorff. Schwager's species name *"politus"* was already preoccupied by Reuss, and it is also very doubtful if the California species is the same as that from Kar Nicobar.

ROBULUS cf. MAYI Cushman and Parker (Pl. 8, figs. 10 a, b)

This is the only specimen in our material, and is from Locality 1102. It has been compared with the types, and seems closely related.

SARACENARIA SCHENCKI Cushman and Hobson, n. sp. (Pl. 8, figs. 11 a, b)

Test close coiled except the last two or three chambers which tend to become uncoiled, strongly keeled, transverse section generally triangular, apertural face three-sided, with the base convex from below, the sides strongly curved and convex; chambers distinct, increasing gradually in height as added, little if at all inflated, the inner angles with a distinct spinose process particularly noticeable in front view; sutures distinct, strongly limbate, flush with the surface; wall smooth, very finely perforate; aperture radiate, slightly projecting at the outer angle of the apertural face, with a distinctly larger slit running into the ventral face. Length 0.70 mm.; breadth 0.45 mm.

Holotype (Cushman Coll. No. 22092) from San Lorenzo formation, Bear Creek, just north of southernmost Vaqueros-San Lorenzo contact, Santa Cruz Co., California.

This is quite possibly the same as the form figured by Barbat and von Estorff (Journ. Pal., vol. 7, 1933, pl. 23, fig. 16), although their figure shows little trace of a keel. It is not the same as *Saracenaria italica* Defrance, to which this and allied forms have been referred. A similar form, perhaps the same, occurs in the Tertiary of Venezuela, Trinidad, and Ecuador.

MARGINULINA sp(?) (Pl. 8, figs. 12-14)

There are so many variations of the smooth forms of *Marginulina* in our American Tertiary that it is very difficult to select a specific name that will really represent the species. It has been customary to refer such forms as figured here to *Marginulina subbullata* Hantken. A study of topotypes of Hantken's species however shows that it has the chambers much more inflated and set off from one another than in these figured here. In our series, the microspheric and megalospheric forms show great differences in the early stages, and also in the general shape and number of chambers in the adult. A glance at the bewildering array of figures given by Neugeboren (Foraminiferen von Felsö-Lapugy unweit Dobra im Carlsburger District, beschreiben und nach der Natur gezeichnet: Artikel III. Marginulina) published in 1851, in which he proposes no less than 34 new names for Miocene species of this one general locality, will give one much to consider before giving a definite name to such a variable form as that figured here.

NODOSARIA cf. KOINA Schwager (Pl. 8, fig. 15)

The figured specimen, which is a fragment showing but three complete chambers, may be referred somewhat questionably to Schwager's species. It is similar to others that have been so referred to by various authors dealing with the Tertiary of California. It is from Locality 987. From the ends, the specimen seems to have a radiate aperture and an apertural chamberlet.

NODOSARIA cf. ANOMALA Reuss (Pl. 8, fig. 16)

The two chambers also from Locality 987 may possibly represent later chambers of this same form. They may be compared also with the fragmentary specimen figured by Barbat and von Estorff as *Nodosaria* (?) sp. (Journ. Pal., vol. 7, 1933, pl. 23, fig. 15).

PSEUDOGLANDULINA GALLOWAYI Cushman (Pl. 8, figs. 17 a, b)

Glandulina comata GALLOWAY and MORREY (not BATSCH), Bull. Amer. Pal., vol. 15, No. 55, 1929, p. 13, pl. 1, figs. 7 *a*, *b*.

Pseudoglandulina gallowayi CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 87, pl. 13, fig. 13.

Our specimen here figured shows an adult specimen which has developed an elongate fusiform test, the final chamber being as usual in this genus, somewhat less involute than the earlier ones. The types of the species are from the Tertiary of Manta, Ecuador. Our specimen is from Locality 987.

The later chambers are slightly more inflated than the type, which is a somewhat immature specimen.

GLANDULINA LAEVIGATA d'Orbigny

There are a number of specimens that seem definitely to be referred to this species. They are from Localities 987 and 1103.

PLECTOFRONDICULARIA VAUGHANI Cushman (Pl. 9, figs. 1 a, b)

Plectofrondicularia vaughani CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 3, 1927, p. 112, pl. 23, fig. 3; Journ. Pal., vol. 1, 1927, pl. 25, fig. 11; Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 92, pl. 13, figs. 21, 22.—CUSHMAN and JARVIS, Journ. Pal., vol. 4, 1930, p. 361, pl. 33, fig. 4.—NUTTALL, l. c., vol. 6, 1932, p. 19.

Flabellina budensis GALLOWAY and MORREY (not HANTKEN), Bull. Amer. Pal., vol. 15, No. 55, 1929, p. 11, pl. 1, fig. 3.

This species occurs in characteristic form in the San Lorenzo material from Locality 987. There are other specimens from Locality 1103. This San Lorenzo material shows specimens very similar to the type which was from Mexico, and also to the form which occurs in Venezuela, Ecuador, and Trinidad. The form figured from Buff Bay, Jamaica, is somewhat more accelerated, so that the typical frondicularian chambers are taken on much earlier. One of the characteristics of the early development is the long reniform second chamber which often encircles the proloculum, and the following chambers are decidedly alternating.

PLECTOFRONDICULARIA cf. MIOCENICA Cushman

There are but two specimens, and these incomplete ones from Locality 1103. They show a form with the early portion covered by two strong longitudinal costae, covering but a few chambers. In some respects, these specimens resemble *Plectofrondicularia packardi* Cushman and Schenck (Univ. Calif. Publ., Bull. Dept.

EXPLANATION OF PLATE 8

FIG. 1. *Bathysiphon* sp(?). × 35. Plesiotype: Cushman Coll. No. 22076. L. S. J. U. Loc. 987.

FIG. 2. *Reophax* cf. *pilulifer* H. B. Brady. × 35. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22077. L. S. J. U. Loc. 987.

FIG. 3. *Cyclammina* cf. *clarki* G. D. Hanna. × 35. *a*, side view; *b*, peripheral view. Plesiotype: Cushman Coll. No. 22078. L. S. J. U. Loc. 987.

FIG. 4. *Cyclammina* cf. *incisa* Stache. × 35. *a*, side view; *b*, peripheral view. Plesiotype: Cushman Coll. No. 22079. L. S. J. U. Loc. 987.

FIG. 5. *Textularia* cf. *gramen* d'Orbigny. × 35. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22080. L. S. J. U. Loc. 987.

FIG. 6. *Verneuilina* sp(?). × 35. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22082. L. S. J. U. Loc. 987.

FIG. 7. *Robulus* sp(?). × 35. *a*, side view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22083. L. S. J. U. Loc. 914.

FIG. 8. *Robulus warmani* Barbat and von Estorff. × 40. *a*, side view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22085. L. S. J. U. Loc. 987.

FIG. 9. *Robulus barbati* Cushman and Hobson, n. sp. × 35. *a*, side view; *b*, apertural view. Holotype: Cushman Coll. No. 22087. L. S. J. U. Loc. 914.

FIG. 10. *Robulus* cf. *mayi* Cushman and Parker. × 80. *a*, side view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22088. L. S. J. U. Loc. 914.

FIG. 11. *Saracenaria schencki* Cushman and Hobson, n. sp. × 50. *a*, side view; *b*, apertural view. Holotype: Cushman Coll. No. 22092. L. S. J. U. Loc. 914.

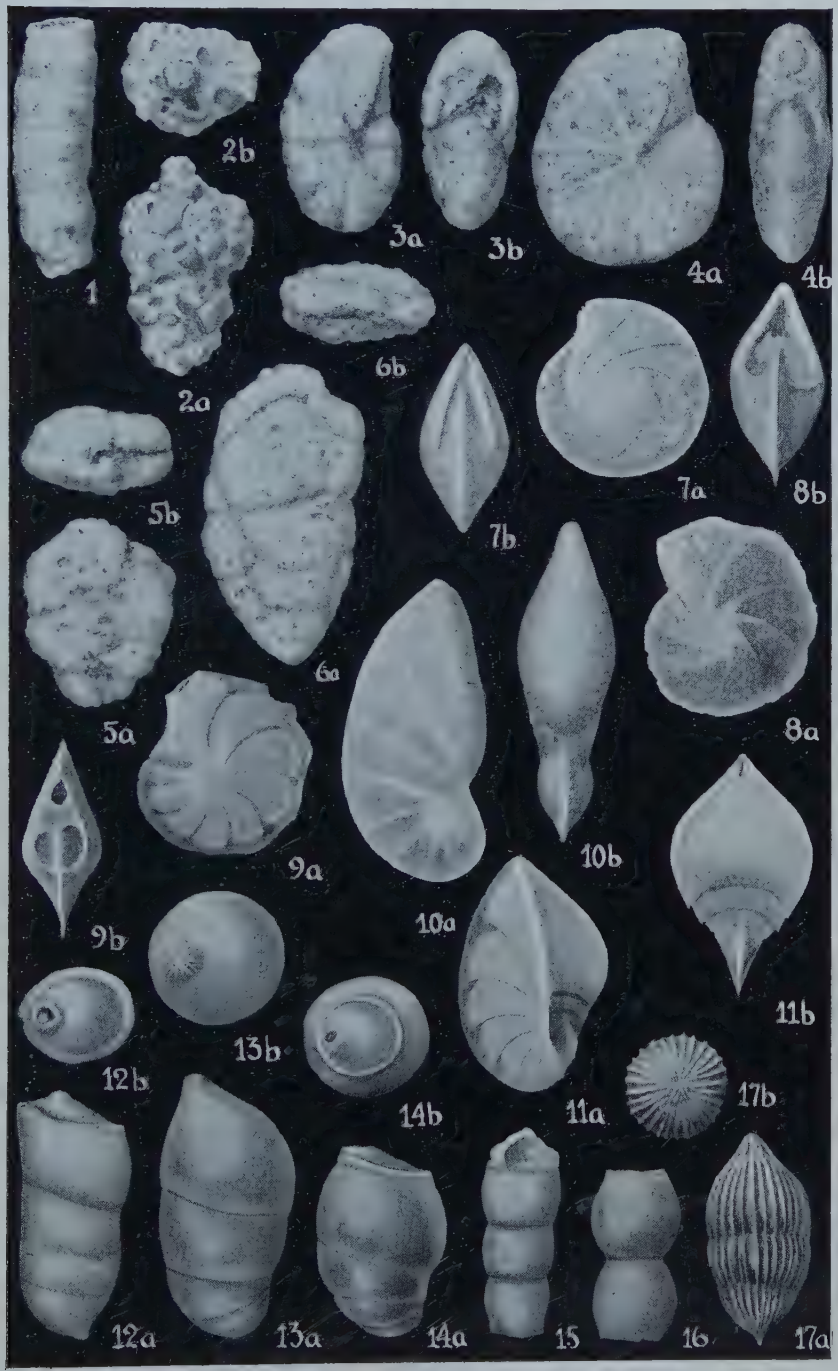
FIGS. 12–14. *Marginulina* sp(?). × 60. *a*, *a*, *a*, side views; *b*, *b*, *b*, apertural views. Plesiotypes: Fig. 12, Cushman Coll. No. 22089. Fig. 13, Cushman Coll. No. 22091. Fig. 14, Cushman Coll. No. 22090. Figs. 12-14, L. S. J. U. Loc. 987.

FIG. 15. *Nodosaria* cf. *koina* Schwager. × 35. Plesiotype: Cushman Coll. No. 22102. L. S. J. U. Loc. 987.

FIG. 16. *Nodosaria* cf. *anomala* Reuss. × 35. Plesiotype: Cushman Coll. No. 22094. L. S. J. U. Loc. 987.

FIG. 17. *Pseudoglandulina gallowayi* Cushman. × 50. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22095. L. S. J. U. Loc. 987.

Figures 7, 8, 9, 10, 11, 17 drawn by J. A. Cushman; others by Margaret S. Moore.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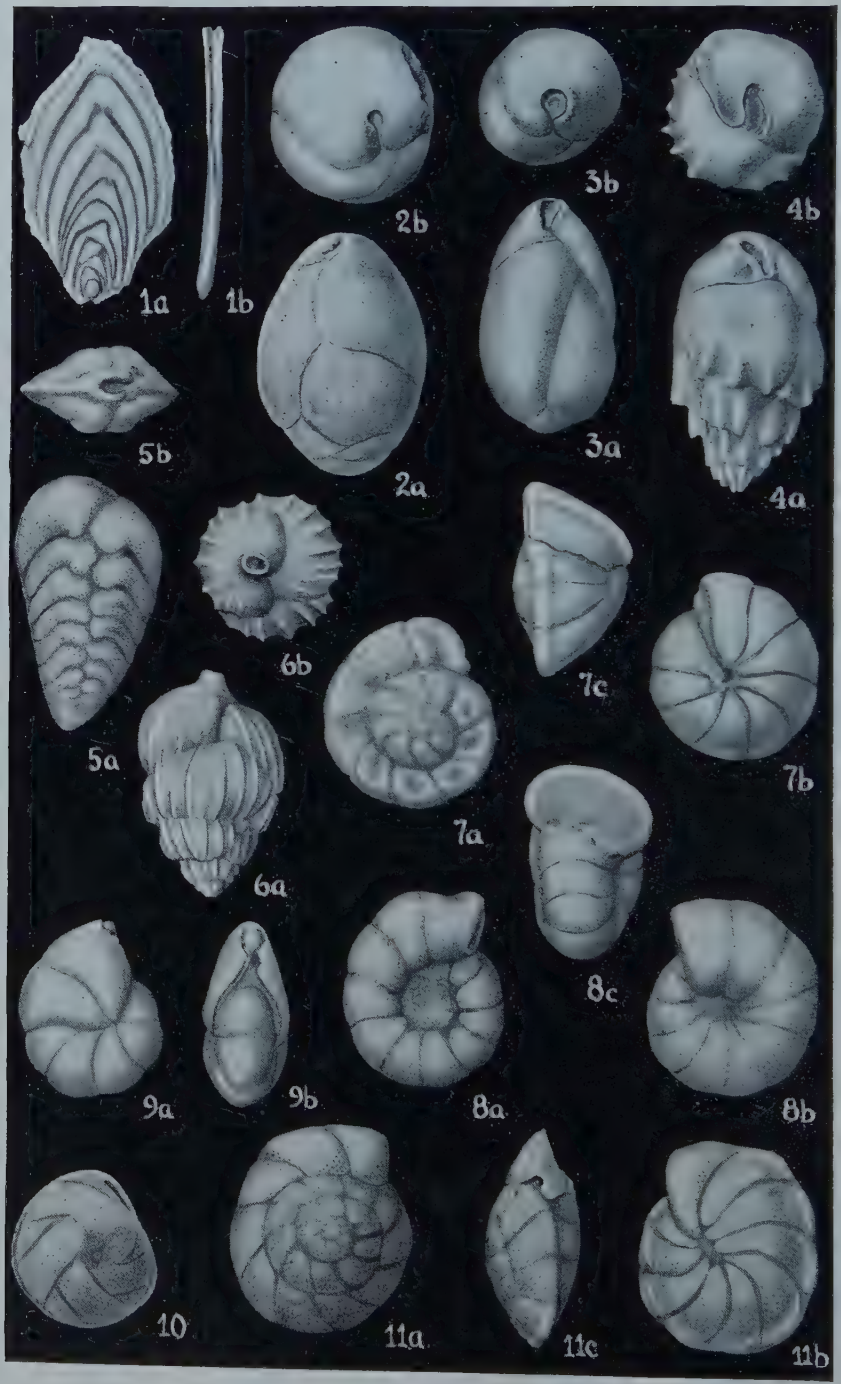
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Geol. Sci., vol. 17, 1928, p. 311, pl. 43, figs. 14, 15) described from the Tertiary of Oregon. More and better specimens are necessary for a more satisfactory determination of this form.

These species represented by our specimens should be carefully compared with that figured as *Plectofrondicularia* n. sp. without name by Barbat and von Estorff (Journ. Pal., vol. 7, 1933, p. 170, pl. 23, fig. 5) from the Lower Miocene of California.

EXPLANATION OF PLATE 9

FIG. 1. *Plectofrondicularia vaughani* Cushman. × 60. *a*, front view; *b*, side view. Plesiotype: Cushman Coll. No. 22100. L. S. J. U. Loc. 987.

FIG. 2. *Bulimina* cf. *socialis* Bornemann. × 50. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22103. L. S. J. U. Loc. 987.

FIG. 3. *Globobulimina* cf. *pacifica* Cushman. × 35. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22104. L. S. J. U. Loc. 914.

FIG. 4. *Bulimina* cf. *rinconensis* Cushman and Laiming. × 80. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22107. L. S. J. U. Loc. 914.

FIG. 5. *Bolivina* sp(?). × 60. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22108. L. S. J. U. Loc. 914.

FIG. 6. *Uvigerinella obesa* Cushman, var. *impolita* Cushman and Laiming. × 80. *a*, front view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22110. L. S. J. U. Loc. 987.

FIG. 7. *Gyroidina soldanii* d'Orbigny. × 60. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Plesiotype: Cushman Coll. No. 22113. L. S. J. U. Loc. 987.

FIG. 8. *Anomalina californiensis* Cushman and Hobson, n. sp. × 60. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. Holotype: Cushman Coll. No. 22123. L. S. J. U. Loc. 987.

FIG. 9. *Pullenia octoloba* Barbat and von Estorff. × 60. *a*, side view; *b*, apertural view. Plesiotype: Cushman Coll. No. 22118. L. S. J. U. Loc. 914.

FIG. 10. *Cassidulina crassipunctata* Cushman and Hobson, n. sp. × 50. Holotype: Cushman Coll. No. 22119. L. S. J. U. Loc. 987.

FIG. 11. *Cibicides pseudoungerianus* (Cushman), var. *evolutus* Cushman and Hobson, n. var. × 60. *a*, dorsal view; *b*, ventral view; *c*, apertural view. Holotype: Cushman Coll. No. 22125. L. S. J. U. Loc. 987.

Figures 1, 2, 10 drawn by J. A. Cushman; others by Margaret S. Moore.

BULIMINA cf. SOCIALIS Bornemann (Pl. 9, figs. 2 a, b)

The specimen figured is very close to the one described by Bornemann from the Oligocene of Hermsdorff near Berlin (Zeitschr. deutsch. geol. Gesell., vol. 7, 1855, p. 342, pl. 16, fig. 10). It is from Locality 987.

BULIMINA cf. RINCONENSIS Cushman and Laiming (Pl. 9, figs. 4 a, b)

The figured specimen is from Locality 914, and it occurs in some numbers at Locality 1102. The series of specimens shows some variation, but in general they resemble the form described by Cushman and Laiming from Ventura Co., California (Journ. Pal., vol. 5, 1931, p. 107, pl. 11, figs. 18 *a, b*).

GLOBOBULIMINA cf. PACIFICA Cushman (Pl. 9, figs. 3 a, b)

The figured specimen is from Locality 914. The same form also occurs at Localities 1102 and 1103. From the three stations there are several specimens showing very little variation in form and the relative amount of involution of the chambers.

BOLIVINA sp(?) (Pl. 9, figs. 5 a, b)

The figured specimen is from Locality 914, but the species occurs in greater abundance at Locality 1102. The figure does not show as much keel as occurs, and probably represents an immature specimen. In some respects, the larger but incomplete specimens resemble somewhat the earlier stages of *B. alazanensis* Cushman. None of the adult specimens are complete.

UVIGERINELLA OBESA Cushman, var. IMPOLITA Cushman and Laiming (Pl. 9, figs. 6 a, b)

Uvigerinella obesa CUSHMAN, Journ. Pal., vol. 5, 1931, p. 111, pl. 12, figs. 11 *a, b*.—BARBAT and VON ESTORFF, l. c., vol. 7, 1933, p. 171, pl. 23, figs. 10 *a, b*.

There are a number of specimens similar to that here figured, the early stages of which appear to belong to *Uvigerinella,* and resemble closely the figures given in the above references. Our figured specimen is from Locality 987, where it occurs in considerable abundance. It also occurs at Locality 1102.

GYROIDINA SOLDANII d'Orbigny (Pl. 9, figs. 7 a-c)

This species has been widely recorded in the Tertiary of various regions, but it is possible that a detailed study of it from

different areas and a considerable vertical range may break it up into numerous specific or varietal forms that may be used in close correlation. Our fig. 7 *b* shows the sutures apparently raised, but they are really either flush with the surface or usually slightly depressed. The species has occurred at Localities 987, 1102, and 1103.

At Locality 1102, there is a specimen with a very rounded periphery which is probably distinct from the typical form with its sharply angular, peripheral edge.

CASSIDULINA CRASSIPUNCTATA Cushman and Hobson, n. sp. (Pl. 9, fig. 10)

Test strongly umbonate, periphery distinctly and sharply keeled, the central umbonate region mostly clear, showing the chambers of the earlier coils; chambers distinct, elongate, four to five pairs in the adult whorl, slightly if at all inflated; sutures very distinct, strongly limbate, nearly tangential, nearly straight, not depressed; wall coarsely perforate, otherwise smooth; aperture narrowly elongate, with a small tooth at one side. Diameter 0.45-0.50 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 22119) from the Tertiary, San Lorenzo formation, Bear Creek, about 2,500′ north of southernmost Vaqueros-San Lorenzo contact, Santa Cruz Co., California. It also occurs at Locality 1103.

The species is a rather thick one, and distinctly and coarsely perforate, with a clear central umbo. In some respects it resembles *Cassidulina laevigata* d'Orbigny, var. *carinata* Cushman.

CASSIDULINA sp(?)

There are a few very poorly preserved specimens of a very thick species which occurred at Locality 1103. There are not enough of these nor are they well enough preserved to warrant a specific identification.

PULLENIA OCTOLOBA Barbat and von Estorff (Pl. 9, figs. 9 a, b)

Pullenia octoloba Barbat and von Estorff, Journ. Pal., vol. 7, 1933, p. 173, pl. 23, figs. 11 *a*, *b*.

This species was described from the Lower Miocene of the southern lower San Joaquin Valley, California. We have two specimens, one from Locality 914, the figured one, and the other from Locality 1102. In both cases, the specimen has been some-

what crushed, especially the last two chambers. Both specimens also show seven instead of eight chambers in the final coil. Whether or not this would hold constant in a larger series of specimens remains to be determined.

ANOMALINA CALIFORNIENSIS Cushman and Hobson, n. sp. (Pl. 9, figs. 8 a-c)

Test nearly bilaterally symmetrical, the ventral side almost completely involute, dorsal side less so, and showing portions of the earlier coils, dorsal side somewhat flattened, slightly excavated in the middle portion, ventral side distinctly umbilicate, periphery very broadly rounded; chambers about ten in the last-formed whorl, distinct, slightly inflated, of rather uniform shape throughout, and increasing very gradually in size as added; sutures distinct, somewhat limbate, nearly radiate, slightly curved and slightly depressed, except on the dorsal side in the earlier coils, where they are flush with the surface, the spiral suture on the dorsal side somewhat more thickened than the ones between the chambers; wall fairly smooth, coarsely and distinctly perforate; aperture at the base of the apertural face, peripheral. Diameter 0.40-0.50 mm.; thickness 0.25-0.30 mm.

Holotype (Cushman Coll. No. 22123) from Tertiary of San Lorenzo formation, Bear Creek, about 2,500′ north of northernmost Vaqueros-San Lorenzo contact, Santa Cruz Co., California.

This species in some respects resembles *A. glabrata* Cushman, described from off Samoa. It is however a much thicker species, and seems to be distinct. This species also occurs at Localities 1102 and 1103.

CIBICIDES PSEUDOUNGERIANUS (Cushman), var. EVOLUTUS Cushman and Hobson, n. var. (Pl. 9, figs. 11 a-c)

Variety differing from the typical in having the dorsal side much more evolute.

Holotype of variety (Cushman Coll. No. 22125) from Tertiary of San Lorenzo formation, Bear Creek, about 2,500′ north of southernmost Vaqueros-San Lorenzo contact, Santa Cruz Co., California.

This variety is very distinctive in this material. It has the general characters of *C. pseudoungerianus* (Cushman), but the dorsal side is strongly evolute so that the chambers of the last-formed whorl, which are about ten in number, have their length and breadth about equal. The variety is common at the type locality, 987, and also occurs at Locality 1102.

159. CRETACEOUS FORAMINIFERA FROM THE MORENO SHALE OF CALIFORNIA

By J. A. Cushman and A. S. Campbell

Comparatively little has been published in regard to the foraminifera of the Cretaceous of the West Coast of America. A paper by Cushman and Church (Some Upper Cretaceous Foraminifera from near Coalinga, California: Proc. Calif. Acad. Sci., ser. 4, vol. xviii, No. 16, 1929, pp. 497-530, pls. 36-41) described and figured many species. Few if any of the species described from Coalinga are found in our material. This is not surprising when it is considered that the Coalinga material came from the Chico, and our material from the younger Moreno.

The material which forms the basis for the present paper came from an experimental well on the leasehold of the Amerada Exploration Company, to whom we are indebted for the material. The well is near Tracy, California, approximately one mile north of that village. The section in this region includes a prominent capping of alluvium, San Pablo (Upper Miocene), and a great thickness of underlying Cretaceous. Of the latter, the uppermost is mapped as Moreno, and the lower as Panoche. Both of these are very thick, and the Moreno here is supposed to include about 5,000 feet of the section. Our problem has been a study of the foraminiferal fauna rather than to attempt any discussion of the geology. In addition to the foraminifera, there are a few Mollusc fragments: *Pecten?*, *Inoceramus*, and possibly *Baculites*.

The foraminiferal faunule, while consisting of but a few species, suggests relationships with the uppermost Cretaceous of the Gulf Coastal Plain region, but especially with the Velasco shale of Mexico and the uppermost Cretaceous of Trinidad. The striking species, *Nodosaria velascoensis* Cushman, known from both Mexico and Trinidad, is present in the samples from the well at Tracy, in very typical form. The new species, *Frondicularia seminiformis*, also occurs in the Velasco shale of Mexico. Some of the other species seem to range somewhat lower in the Gulf Coastal Plain Cretaceous section. Several of the species are apparently undescribed, and others seem identical with

Upper Cretaceous species of Europe. A few need more material before they can be specifically determined with any degree of certainty.

The abundance of Lagenidae and absence of such common Cretaceous genera as *Gümbelina, Globorotalia,* and *Globotruncana,* should be noted. This agrees in general with the Velasco shale fauna.

GAUDRYINA NAVARROANA Cushman, var. CRASSAFORMIS Cushman and Campbell, n. var. (Pl. 10, fig. 1)

Variety differing from the typical in the later biserial chambers, which are somewhat thicker in section than in the typical, and in the stronger keels of the triserial portion. Length slightly more than 1.00 mm.; breadth 0.40 mm.; thickness 0.25 mm.

Holotype of variety (Cushman Coll. No. 22129) from Upper Cretaceous, Moreno shale, at a depth of 4,500 feet in well, 1 mile north of Tracy, California.

The general appearance of this form is strikingly like that of *Gaudryina navarroana* Cushman, both in the texture and color of the test, and in the flattening of the later chambers. Specimens of typical *G. navarroana* with as many biserial chambers are rare, but they are to be found in any large series.

MARGINULINA GRATA (Reuss) (Pl. 10, fig. 2)

Cristellaria grata REUSS, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 70, pl. 7, figs. 14 *a, b.*—CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 598, pl. 19, figs. 1 *a, b.*

Lenticulina grata CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 96, pl. 14, fig. 3.

Marginulina grata CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, art. 14, 1932, p. 25, pl. 7, figs. 7 *a, b*; pl. 8, figs. 3 *a, b.*

Test elongate, compressed, periphery rounded; chambers few, distinct, not inflated, early ones coiled, later portion tending to uncoil, of rather uniform height, increasing gradually in height as added; sutures distinct, slightly limbate, not depressed, slightly curved; wall smooth; aperture radiate, at the peripheral margin. Length of figured specimen 0.60 mm.; breadth 0.30 mm.

This species is recorded from the Upper Cretaceous of Mexico and Trinidad. It is widely distributed in the Upper Cretaceous of Europe and America. There is considerable difference in shape of the microspheric and megalospheric forms.

MARGINULINA STRIATO-CARINATA Cushman and Campbell, n. sp. (Pl. 10, figs. 4, 7)

Test elongate, early portion close coiled and thickened, later portion uncoiling, somewhat more compressed, periphery of the early portion with a distinct, thin carina which extends some distance up the dorsal side; chambers fairly distinct, those of the coiled portion narrow, in the uncoiled portion becoming nearly as high as broad, and tending to become inflated; sutures fairly distinct, those of the adult uniserial portion tending to become slightly depressed; wall fairly thick, in well preserved specimens showing fine, elongate striations, running longitudinally of the test, and independent of the individual chambers; aperture radiate, slightly projecting. Length up to 1.50 mm.; breadth 0.65 mm.

Holotype (Cushman Coll. No. 22130) from Upper Cretaceous, Moreno shale, at a depth of 4,500 feet in well, 1 mile north of Tracy, California.

There is considerable difference in the appearance of microspheric and megalospheric specimens, the latter having but a very few uncoiled chambers, while the microspheric form is much more elongate with twice as many uncoiled chambers in the adult test.

In some respects, this suggests "*Cristellaria inflata* Reuss" from the Upper Cretaceous of Europe, but ours is not as inflated, and the uncoiled portion is very different.

MARGINULINA cf. BRONNI (Roemer) (Pl. 11, fig. 4)

The figured specimen is the only one available in our material, and its identification must be made with some uncertainty. It resembles in some respects the figure given by Reuss of "*Cristellaria bronni* (Roemer)" (Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 70, pl. 7, figs. 13 *a*, *b*) from the Upper Cretaceous of Europe.

The early stages of our specimen are more compressed than is shown by Reuss, but the later chambers are very similar. Additional material of this particular form is needed from the Moreno.

FLABELLINA PILULIFERA Cushman and Campbell, n. sp. (Pl. 10, figs. 6 a, b)

Test much compressed, the proloculum and immediately succeeding chambers forming an initial, thickened mass, of greater thickness than the remainder of the test, otherwise the test thickest in the median line, thence gradually more compressed

toward the squarely truncate periphery, base of test nearly a straight line in the adult, sides convex, more strongly so on the basal half; chambers numerous, early ones planispiral and close coiled, gradually lengthening and tending to uncoil with the frondicularian chambers taken on rather early, distinct except the earliest which form a thickened, somewhat eccentric raised mass on both sides of the test; sutures distinct, raised into a thin carina, smooth in the flabelline stage, but in the frondicularian chambers with the lower half broken into a series of raised beads, in the latest sutures beaded only toward the base or wanting; wall with deep grooves between the sutures and smooth, the early raised portion with a few rounded costae; aperture radiate, terminal, slightly projecting. Length 1.50 mm.; breadth 1.00 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 22134) from Upper Cretaceous, Moreno shale, at a depth of 4,500 feet in well, 1 mile north of Tracy, California.

EXPLANATION OF PLATE 10

All specimens from a depth of 4,500 feet in well, 1 mile north of Tracy, California.

FIG. 1. *Gaudryina navarroana* Cushman, var. *crassaformis* Cushman and Campbell, n. var. × 50. Holotype: Cushman Coll. No. 22129.

FIG. 2. *Marginulina grata* (Reuss). × 60. Plesiotype: Cushman Coll. No. 22132.

FIG. 3. *Dentalina* cf. *megapolitana* Reuss. × 60. Plesiotype: Cushman Coll. No. 22139.

FIGS. 4, 7. *Marginulina striato-carinata* Cushman and Campbell, n. sp. × 40. Fig. 4, Holotype: Cushman Coll. No. 22130. Fig. 7, Paratype: Cushman Coll. No. 22131.

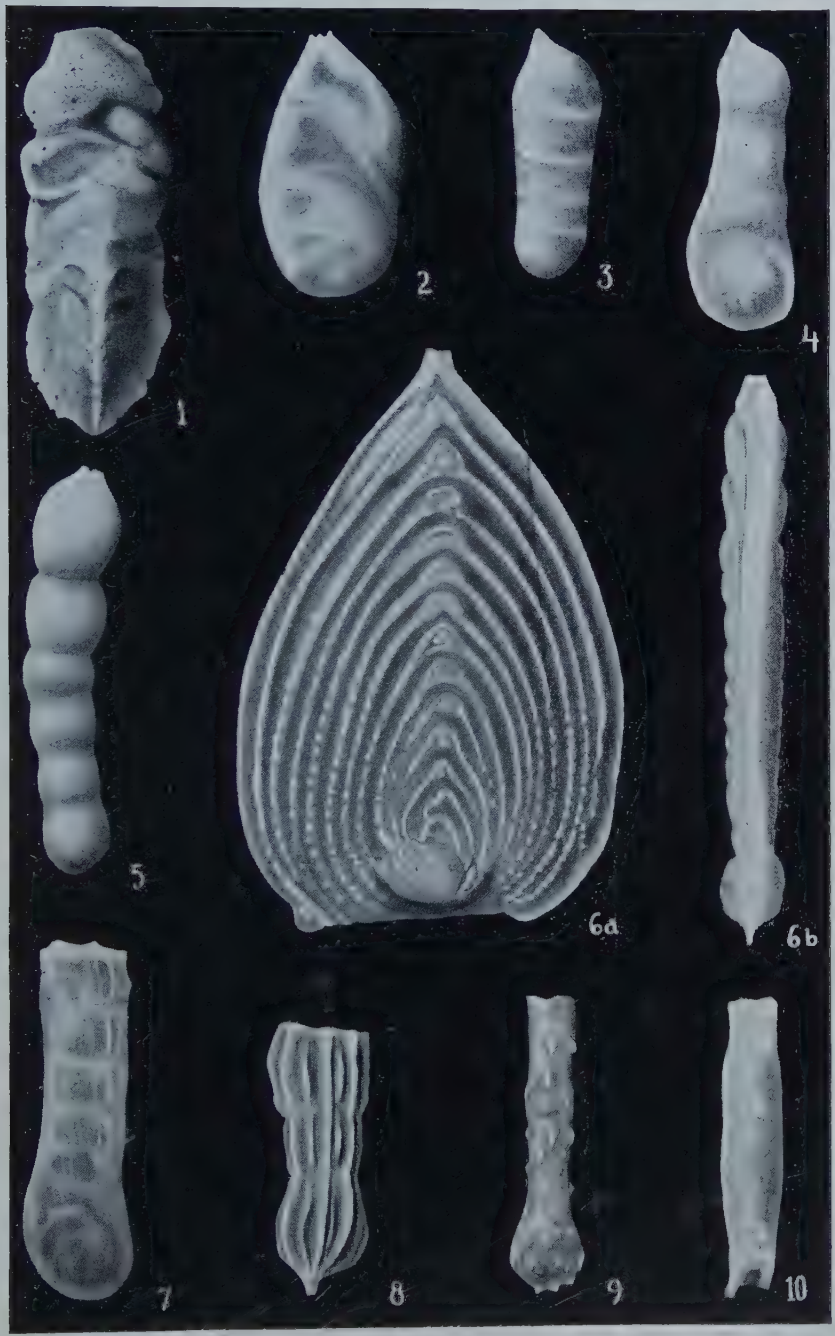
FIG. 5. *Nodosaria monile* v. Hagenow. × 27. Plesiotype: Cushman Coll. No. 22140.

FIG. 6. *Flabellina pilulifera* Cushman and Campbell, n. sp. × 33. *a*, front view; *b*, peripheral view. Holotype: Cushman Coll. No. 22134.

FIG. 8. *Nodosaria* cf. *alternata* Jones. × 60. Plesiotype: Cushman Coll. No. 22141.

FIGS. 9, 10. *Nodosaria spinifera* Cushman and Campbell, n. sp. × 33. Fig. 9, Holotype: Cushman Coll. No. 22142. Fig. 10, Paratype: Cushman Coll. No. 22143.

Figures drawn by Ann Shepard.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This is one of the striking species of this collection, and as a rather specialized one, should make an excellent horizon marker. It is rather unique in its beaded, raised sutures with the intermediate, depressed areas smooth, and the peculiar raised area at the start of the development. At first, it was thought that the early chambers might be arranged as in *Kyphopyxa*, but sections seem to show them all flabelline. All our specimens are megalospheric.

VAGINULINA cf. SIMONDSI Carsey (Pl. 11, fig. 7)

There is a single specimen in this sample that has a very straight dorsal side with a raised ridge, the chambers very elongate and curved, and the sutures raised, but with costae on them parallel to the dorsal margin of the test. This is very similar to the specimen figured from near Coalinga (Cushman and Church, Proc. Calif. Acad. Sci., ser. 4, vol. xviii, 1929, p. 508, pl. 38, fig. 10).

EXPLANATION OF PLATE 11

All specimens from a depth of 4,500 feet in well, 1 mile north of Tracy, California.

FIG. 1. *Nodosaria* sp(?). × 60. Plesiotype: Cushman Coll. No. 22144.

FIG. 2. *Nodosaria* sp(?). × 27. Plesiotype: Cushman Coll. No. 22145.

FIG. 3. *Nodosaria velascoensis* Cushman. × 60. Plesiotype: Cushman Coll. No. 22146.

FIG. 4. *Marginulina* cf. *bronni* (Roemer). × 33. Plesiotype: Cushman Coll. No. 22133.

FIG. 5. *Frondicularia seminiformis* Cushman and Campbell, n. sp. × 50. *a*, front view; *b*, peripheral view. Holotype: Cushman Coll. No. 22136.

FIG. 6. *Frondicularia* sp(?). × 27. Plesiotype: Cushman Coll. No. 22137.

FIG. 7. *Vaginulina* cf. *simondsi* Carsey. × 33. Plesiotype: Cushman Coll. No. 22150.

FIG. 8. *Frondicularia archiaciana* d'Orbigny. × 40. *a*, front view; *b*, peripheral view. Plesiotype: Cushman Coll. No. 22138.

FIG. 9. *Bolivina* cf. *decurrens* (Ehrenberg). × 60. Plesiotype: Cushman Coll. No. 22148.

FIG. 10. *Bolivina incrassata* Reuss. × 60. Plesiotype: Cushman Coll. No. 22149.

FIG. 11. *Bulimina spinata* Cushman and Campbell, n. sp. × 60. Holotype: Cushman Coll. No. 22147.

Figures drawn by Ann Shepard.

FRONDICULARIA SEMINIFORMIS Cushman and Campbell, n. sp. (Pl. 11, figs. 5 a, b)

Frondicularia sp(?) CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 598, pl. 20, fig. 4.

Test elongate, elliptical, compressed, especially the later chambers, initial end with a stout, acicular spine, periphery squarely truncate, the apertural end extended into a tubular neck; chambers few, distinct, the proloculum elongate, thicker than the later chambers, and with a median, longitudinal ridge, later chambers not quite meeting at the base, but fused with the initial spine; sutures distinct, slightly limbate, somewhat depressed; wall smooth; aperture at the end of an extended, tubular neck. Length of holotype 1.00 mm.; breadth 0.45 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 22136) from Upper Cretaceous, Moreno shale, at a depth of 4,500 feet in well, 1 mile north of Tracy, California.

This is the same as the species figured without a name in the above reference from the Velasco shale of the Tampico Embayment, Mexico. The proloculum is very elongate, and has a prominent, longitudinal, median costa.

FRONDICULARIA sp(?) (Pl. 11, fig. 6)

The broken specimen here figured is the only one of this species in our sample. It somewhat reminds one of *Frondicularia inversa* Reuss, but is probably not that species. The proloculum is a very elongate one, and succeeding chambers are also very elongate. The later part of the test is broken, and it is impossible to tell what the characters may have been. There is little in the Upper Cretaceous material from either Trinidad or Mexico that resembles it. It is barely possible that the apertural end of a specimen from Trinidad questionably identified as "*Frondicularia cordai* Reuss" (Cushman and Jarvis, Proc. U. S. Nat. Mus., vol. 80, art. 14, 1932, p. 39, pl. 12, fig. 4) may belong to the same form. The identification of the California form must await the finding of more and better specimens.

FRONDICULARIA ARCHIACIANA d'Orbigny (Pl. 11, figs. 8 a, b)

The figured specimen is rather typical of this species described by d'Orbigny from the Uppermost Cretaceous of Europe. The proloculum is globular, but succeeding chambers are much compressed. The initial chamber typically has longitudinal costae.

DENTALINA cf. MEGAPOLITANA Reuss (Pl. 10, fig. 3)

The single, somewhat immature specimen here figured is referred to Reuss's species. It is evidently a megalospheric specimen, and others are needed to confirm the identification. The species has also been recorded from the Upper Cretaceous of Trinidad and from the Velasco shale of Mexico.

NODOSARIA MONILE v. Hagenow (Pl. 10, fig. 5)

The figured specimen is slightly curved, and inclines toward *Dentalina,* but other specimens in the series are more nearly straight. This same form was recorded from the Upper Cretaceous of Trinidad (Cushman and Jarvis, Proc. U. S. Nat. Mus., vol. 80, art. 14, 1932, p. 33, pl. 10, fig. 9).

NODOSARIA cf. ALTERNATA Jones (Pl. 10, fig. 8)

There is in our material a single broken specimen figured here which may be referred to the above species. The range of this species is however usually lower than most of the other species recorded here, and additional as well as better specimens are desirable before the identification can be confirmed.

NODOSARIA SPINIFERA Cushman and Campbell, n. sp. (Pl. 10, figs. 9, 10)

Test elongate, slender, circular in transverse section; chambers indistinct, proloculum of greater diameter than succeeding chambers, which increase greatly in length as added, in the adult several times as long as the diameter; sutures indistinct, slightly depressed in the adult; wall thick, with numerous, short, backwardly projecting spines appearing white against the darker background of the chamber wall, and in the adult but slightly projecting, appearing largely as lighter areas in the wall.

Holotype (Cushman Coll. No. 22142) from Upper Cretaceous, Moreno shale, at a depth of 4,500 feet in well, 1 mile north of Tracy, California.

No complete specimens were recovered from our material. The peculiar spinose ornamentation of the wall is a very peculiar one, and the shape of the chambers very different from the usual spinose species found in the Upper Cretaceous.

NODOSARIA sp(?) (Pl. 11, fig. 1)

The figured specimen in some respects resembles that given on our Plate 10, fig. 5, but the apertural characters are somewhat

different, and the general appearance of the chambers as well as the way in which they are joined suggest that the two may be distinct. A larger series is needed to bring out the resemblance or difference and the consequent identification.

NODOSARIA sp(?) (Pl. 11, fig. 2)

The fragmentary specimen here figured consists of but three chambers, yet gives the essential characters of the adult stage. The costae of the chambers are prominent, sharp and high, about 13-15 on each chamber. Over the deeply depressed sutural regions the costae are generally wanting. In some respects, this resembles the forms usually assigned to *Nodosaria affinis* Reuss, but the costae in that species are usually continuous, and the sutural regions more sharply depressed. Somewhat similar fragments occur in the Velasco shale of Mexico. The species is evidently a large one, but easily broken. Further material is very desirable.

NODOSARIA VELASCOENSIS Cushman (Pl. 11, fig. 3)

Nodosaria fontannesi (BERTHELIN), var. *velascoensis* CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 594, pl. 18, fig. 12.

Nodosaria velascoensis CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 97, pl. 13, figs. 15, 16; Proc. U. S. Nat. Mus., vol. 80, art. 14, 1932, p. 35, pl. 11, figs. 1-4.

This striking species was originally described from the Upper Cretaceous, Velasco shale of the Tampico Embayment region of Mexico. It has also occurred in typical form in the Upper Cretaceous of Trinidad. Our figured specimen from the well at Tracy is a very typical one, and helps in the correlation of this part of the Moreno shale with the Upper Cretaceous of Mexico and Trinidad.

BULIMINA SPINATA Cushman and Campbell, n. sp. (Pl. 11, fig. 11)

Test triserial, short and broad, rapidly enlarging from the acute, initial end to the greatest breadth formed by the last whorl; chambers distinct, strongly inflated, enlarging rapidly as new whorls are developed, each undercut at the base, leaving a distinct ridge near the lower margin; sutures distinct, depressed; wall of the early chambers with numerous, distinct, spinose projections running back onto the chamber wall as raised costae, becoming greatly reduced, and disappearing on the main body of

the chamber, last-formed whorl of chambers with the wall smooth; aperture, an elongate, narrow opening, running into the base of the last-formed chamber, with a trace of a lateral tooth. Length 0.50 mm.; diameter 0.35 mm.

Holotype (Cushman Coll. No. 22147) from Upper Cretaceous, Moreno shale, at a depth of 4,500 feet in well, 1 mile north of Tracy, California.

A somewhat similar form is found in the Velasco shale of Mexico, and the two may prove to be the same.

BULIMINA OBTUSA d'Orbigny

There are specimens in the material from the Tracy well, which are entirely smooth, and closely resemble the abundant species of the Navarro usually referred to d'Orbigny's species.

BOLIVINA cf. DECURRENS (Ehrenberg) (Pl. 11, fig. 9)

The single figured specimen is considerably crushed and somewhat distorted, but in its general characters resembles Ehrenberg's species which occurs in the Upper Cretaceous, Navarro shale, of Texas. Ehrenberg described this species from the Upper Cretaceous of Europe. The initial end has usually one or more spinose projections.

BOLIVINA INCRASSATA Reuss (Pl. 11, fig. 10)

The specimen figured seems to belong to this species, which is widely distributed in the Upper Cretaceous of Europe and America. The species does not occur usually as high in the section as the Navarro, nor in the Velasco shale of Mexico, although it is a common species of the lower Mendez shale. More specimens are therefore needed to confirm this identification, as it may be but the early stage of a *Loxostomum*.

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand.

Lacroix, Dr. E. *Discammina fallax* et *Haplophragmium emaciatum*.—Bull. Inst. Océanographique, No. 667, Mar. 15, 1935, pp. 1-16, 9 text figs.—Gives a detailed account with figures of the internal structure of these two forms.

Thompson, M. L. The Fusulinid Genus *Staffella* in America.—Journ. Pal., vol. 9, No. 2, March, 1935, pp. 111-120, pl. 13.—Gives a detailed discussion of the genus, with two new species, *Staffella atokensis*, and *S. hollingsworthi*, and a new variety, *S. keytei, maccoyensis*. A new name, *S. moellerana*, is also proposed, and a new genus, *Ozawainella*, erected.

Nuttall, W. L. F. Upper Eocene Foraminifera from Venezuela.—Journ. Pal., vol. 9, No. 2, March, 1935, pp. 121-131, pls. 14, 15.—Describes 54 species and varieties, mostly figured, of which the following are described as new: *Clavulina venezuelana, Marginulina cocoaensis* var. *venezuelana, Gümbelina venezuelana, Discorbis mirandensis, Planulina venezuelana, Eponides bolivarensis*, and *Cibicides venezuelanus*.

Colom, G. Las especies de la familia *Peneroplidae* actuales y fósiles de las Baleares.—Bol. Soc. Española Hist. Nat., vol. XXXV, 1935, pp. 83-102, pls. VI-XVI, 5 text figs.—11 species discussed with numerous figures; 1 new species, *Spirolina navarroi*.

Schenck, Hubert G. What is the Vaqueros Formation of California, and Is It Oligocene?—Bull. Amer. Assoc. Petr. Geol., vol. 19, No. 4, April, 1935, pp. 521-536.—Mentions several species of foraminifera.

Cushman, Joseph A. Paleozoic Foraminifera, their Relationships to Modern Faunas, and to their Environment.—Journ. Pal., vol. 9, No. 3, April, 1935, pp. 284-287.

Yabe, Hisakatsu and **Shoshiro Hanzawa.** Foraminifera? Remains from Ordovician Limestone of Manchuria.—Proc. Imperial Acad., vol. XI (1935), No. 2, pp. 55-57, text figs. 1-3.

Jedlitschka, Heinrich. Beitrag zur Kenntnis der Mikrofauna der subbeskidischen Schichten.—Mitth. nat. Ver. Troppau, C. S. R., 1935, Sep. pp. 1-18, pl., figs. 1-19.—Numerous Cretaceous species noted, the following new: *Plectina conversa, Goësella conversa, Flabellinella liebusi*.

Richter, Konrad. Horizontbestimmung von Ober-Kreidegeschieben mittels Foraminiferenstatistik.—"Frankfurter Beiträge zur Geschiebebeforschung" Beiheft zur Zeitschrift für Geschiebeforschung, 1935, pp. 20-28, 3 text figs., and table.—An example of zoning by means of foraminifera.

Schott, Wolfgang. Die Foraminiferen in dem äquatorialen Teil des Atlantischen Ozeans.—Wissenschaftliche Ergebnisse der deutschen Atlantischen Expedition auf dem Forschungsund Vermessungsschiff "Meteor" 1925-1927, Bd. III, Pt. 3, Section B, 1935, pp. 43-134, 3 charts, text figs. 18-57, (maps).—Notes the species by stations with general notes on the distribution, etc.

Die jüngste Vergangenheit des äquatorialen Atlantischen Ozeans auf Grund von Untersuchungen an Bodenproben der "Meteor"-Expedition. —Sitz. Abhandl. Nat. Gesell. Rostock, Dritte Folge, Bd. 4, 1933 (June 7, 1934), pp. 48-59, 3 text figs.

Gerth, H. The Distribution and Evolution of the Larger Foraminifera in the Tertiary Sediments.—Proc. Kon. Akad. Wet. Amsterdam, vol. XXXVIII, No. 4, 1935, pp. 1-8, table.—Particularly treats of the East Indian Region.

Israelsky, Merle C. Tentative Foraminiferal Zonation of Subsurface Claiborne of Texas and Louisiana.—Bull. Amer. Assoc. Petr. Geol., vol. 19, No. 5, May 1935, pp. 689-695, 5 text figs.

Jedlitschka, Heinr. Revision der Foraminiferen-gattungen Siphonodosaria, Nodogenerina, Sagrinnodosaria.—Verhandl. Nat. Ver. Brünn, vol. 66, 1935, pp. 61-72, 3 text figs.—Discusses the generic characters, and gives notes on numerous species, none new.

Gravell, Donald W. and **Marcus A. Hanna.** Larger Foraminifera from the Moody's Branch Marl, Jackson Eocene, of Texas, Louisiana, and Mississippi.—Journ. Pal., vol. 9, No. 4, June 1935, pp. 327-340, pls. 29-32, 1 text fig., (map).—Two new species described, *Camerina jacksonensis* and *C. moodybranchensis.*

Thompson, M. L. Fusulinids from the Lower Pennsylvanian Atoka and Boggy Formations of Oklahoma.—Journ. Pal., vol. 9, No. 4, June 1935, pp. 291-306, pl. 26.—Redefines the genus *Fusulinella,* and describes four new species: *F. oliviformis, F. fittsi, F. prolifica,* and *F. trisulcata.*

Myers, Earl H. The Life History of Patellina corrugata Williamson, a Foraminifer.—Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 3, No. 15, 1935, pp. 355-392, pls. 10-16, 1 text fig.—A detailed discussion with many illustrations.

Morphogensis of the Test and the Biological Significance of Dimorphism in the Foraminifer Patellina currugata Williamson.—l. c., vol. 3, No. 16, 1935, pp. 393-404, 1 text fig.

Flandrin, Jacques. Sur la présence du genre Assilina dans l'Eocène Supérieur de l'Algérie.—Bull. Service Carte Geol. Algérie, 2 ser., Stratigraphie. Travaux Récentes des Collaborateurs, fasc. II, 1933, pp. 147-150, pl. I.

Ehrmann, France and **Jacques Flandrin.** Au sujet des grandes Lépidocyclines de l'Éocène des Beni-Afeur (S. de Taher, département de Constantine).—Comptes rendus des séances de l'Académie des Sciences, t. 200, 1935, pp. 152-154.

Flandrin, J. La faune de Tizi Renif, près Dra el Mizan (Algérie).—Bull. Soc. Géol. France, ser. 5, vol. IV, 1934, pp. 251-272, pls. XIV-XVI.—One new species described, *Operculina doncieuxi.*

Hofker, J. Sur Quelques Foraminifères.—Résultats Scientifiques Voy. Ind. Orientales Néerlandaises, vol. II, fasc. I, 1930, pp. 1-12, pls. I-III.—Eleven species discussed, none now.

Gauthier-Lièvre, L. Sur une des singularités de l'Oued Rhir: des Foraminifères thalassoides vivant dans les eaux sahariennes.—Bull. Soc. Hist. Nat. de l'Afrique du Nord, vol. 26, May 1935, pp. 142-147, pl. XII, text figs.—An interesting contribution to our knowledge of brackish water foraminifera.

Cushman, Joseph A. Fourteen New Species of Foraminifera.—Smithsonian Misc. Coll., vol. 91, No. 21, July 23, 1935, pp. 1-9, pls. 1-3.—All species recent from off Puerto Rico.

Upper Eocene Foraminifera of the Southeastern United States.—U. S. Geol. Survey Prof. Paper 181, 1935, pp. i, ii, 1-88, pls. 1-23, 3 distribution charts.—Over two hundred species noted, mostly figured, nine new.

Lalicker, Cecil G. Two New Foraminifera of the Genus Textularia.—Smithsonian Misc. Coll., vol. 91, No. 22, July 22, 1935, pp. 1, 2, pl. 1.—Two new species: *Textularia calva* and *T. lateralis.*

Hugues, José Balta. Estratigrafia de Lobitos y el alto y su Relacion con la Microfauna Local.—Bol. Soc. Geol. Peru, tom. VI, Fasc. 3, 1934, pp. 1-25.—Mentions numerous foraminifera.

Lehner, E. Report on the Possibilities of Establishing an Artesian Water Supply for the Island of Carriacou, with appended notes on the General Geology of Carriacou.—Government Printing Office, St. Georges, Grenada, 1935, pp. 1-6, and map.—Mentions foraminifera.

J. A. C.